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NAVAL ARCTIC RESEARCH LAB BARROW ALASKA  
BIOPHYSICS OF COLD ADAPTATION AND ACCLIMATIZATION.(U)  
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CONTRACT N00014-77-C-0162

TASK No. NR 207-117

TECHNICAL REPORT No. 1

6 Biophysics of Cold Adaptation and Acclimatization,

By

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11 15 October 1977

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12 20p.

9 Annual rept.  
1 Oct 76 - 30 Sep 77

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## NARL ANIMAL RESEARCH FACILITY

### ANNUAL REPORT FOR FY77

#### INTRODUCTION

The Animal Research Facility at the Naval Arctic Research Laboratory provides scientists with unique opportunities to study northern animals, maintained in an arctic environment. Large Carnivores and Rodents live year round in outdoor cages where they are subjected to the temperature and light conditions found only in the arctic. The facility is completing its third year of support from the Office of Naval Research Biophysics Program. This report documents the activities and accomplishments of the Facility during FY77.

#### PROJECTS

During FY77, the Animal Research Facility staff supported more than 17 research projects for a total of 3500 man-hours (Table 1). This Figure does not include man-hours of support provided by the resident Veterinarian and research associates. 15 different scientists were associated with studies at the Facility. Projects included in-house research, investigations of visiting scientists, and logistical support for field studies.

#### IN-HOUSE RESEARCH

##### Post Doctoral Program

During the FY77, post doctoral projects continued to be funded by the Office of Naval Research Biophysics Program. Positions for two research associates were available. At the on-set of FY77, Dr. Tim Casey held the position of research associate at the Facility. He concluded his research in November and left the Facility to take a position at Rutgers University.

Table 1. PROJECTS SUPPORTED BY ANIMAL RESEARCH FACILITY STAFF DURING  
FY 1977

<u>PRINCIPLE INVESTIGATOR</u>	<u>PROJECT TITLE</u>	<u>MAN-HOURS OF SUPPORT+ NOV. 76-SEPT. 77</u>
<u>IN HOUSE PROJECTS</u>		
Casey - Comparative Thermoregulation		23*
Follmann - Cold Adaptation in Arctic Foxes		53
Follmann/Philo/Reynolds - Cold Adaptation of Arctic Grizzly Bears		680
Philo - Resident Veterinarian Research and Social Hier- archy in a Captive Wolf Pack		1791
Reynolds - Seasonal Changes in Activity Patterns		173
Growth Measurement in Young Canids		83
<u>VISITING SCIENTISTS</u>		
Albert - Regional Heterothermy in Arctic Mammals		454*
Baust - Cellular Basis of Heterothermic Function in the Nervous System of Arctic Vertebrates		67*
Bell - Nansen Drift Station Project		23
Blix - Physiological and Biochemical Adaptations in Marine Mammals		18
Casey - Biophysics of Heat Exchange in Arctic Mammals (Nests)		(+)
Folk - Large Arctic Mammal Physiology		21*
Lentfer - Feasibility of Using Implanted Transmitters For Radio-Tracking Polar Bears		17
Underwood - Factors Affecting Cold Tolerance in Arctic Homeotherms		12
<u>SUPPORT FOR FIELD STUDIES</u>		
Batzli - Research on Arctic Tundra Environments (Lemmings)		10
Lentfer - Polar Bear Migrations and Populations		47
White - Research on Arctic Tundra Environments (Reindeer)		29
Total		<u>3501</u>

(+) Provided own technician

+ Support provided by ARF Technicians, caretakers and Supervisor

\* Included time required to collect animals needed by researchers

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During his year as a research associate Casey completed several projects concerning energetics of small arctic mammals. He currently has 2 manuscripts in preparation and a third has been accepted by the Journal of Comparative Physiology. (Table 2) Casey returns to the Facility next year to continue his work on arctic animals.

Three candidates were interviewed for the research associate positions in November. Dr. Erich Follmann, from Anchorage, who has done research on the ecology of red foxes using radio-telemetry techniques, was selected to replace Casey. Follmann arrived at the Facility on December 13.

Follmann's major study is entitled "Cold Adaptation in Arctic Foxes". Its objectives are to determine the influence of activity and ambient temperature on the body temperature of arctic foxes. Temperature-sensitive radio-transmitters have been surgically implanted and also placed on external collars to obtain data on internal body and ambient air temperatures. Observations and temperature readings are made at intervals around the 24 hour clock and will continue through the winter of 1977-78 in order to accumulate information from all seasons of the year.

A second project, entitled "Cold Adaptation in Arctic Grizzly Bears" is being conducted by Erich Follmann, Mike Philo, Harry Reynolds and John Hechtel. This study is being coordinated with the Alaska Department of Fish and Game's research on the population dynamics, movement patterns and habitat utilization of grizzly bears in the Western Brooks Range. Its objectives are 1) to determine habitat use, principle foods eaten and energetic efficiency by analysis of caloric contents of food and feces, 2) to determine body temperatures of free-ranging and denning bears by the use of surgically implanted transmitters; 3) to determine base-line hematology, blood serum chemistry and urine chemistry of wild grizzly bears.

Table 2. PARTIAL BIBLIOGRAPHY OF SCIENTISTS SUPPORTED BY THE NARL  
ANIMAL RESEARCH FACILITY IN FY77

<u>INVESTIGATOR</u>	<u>TITLE</u>	<u>SOURCE</u>
<u>Scientific Papers</u>		
Casey, T.M.	Energy Metabolism of Brown Lemmings at Various Air Temperatures With and Without a Nest.	in preparation
-- Casey, K.K.	Thermoregulation of Arctic Weasels	in preparation
-- Withers, P.C., Casey, K.K.	Metabolic and Respiratory Responses* of Arctic Mammals to Ambient Temperature During the Summer	J. Comp. Physiology (in press)
Follmann, E.	Activity Patterns in Red and Gray Foxes	U of A Biological Sciences Series. Fairbanks, March 18, 1977.
	Thermal Significance of Curling Postures During Sleep in Wolves and Foxes	Paper presented to 28th Alaska Science Conference, Alaska Division, AAAS, Anchorage, Alaska Sept. 23, 1977.
	Environmental Factors in Design of* a Natural Gas Pipeline to Minimize Environmental Impacts in the Arctic and Subarctic	Paper presented to seminar by Woodward Clyde Consultants, SLC, Utah, to NW Pipeline Co. Sept. 27, 1977
Reynolds, P.C.	Activity Patterns of Captive Wolves in Barrow, Alaska	Paper presented to NW section of Wildlife Society, Kalispell Montana, Feb. 1977
	Research Opportunities at the NARL Animal Research Facility	Paper presented at the 28th Alaska Science Conference, Alaska Division AAAS, Anchorage, Alaska, Sept. 23, 1977
<u>Miscellaneous Publications</u>		
Persons, K. Craighead, D.	Animal Research Facility Brochure	Published by U of A

\* Research done prior to scientist's 1977 residency at NARL

From May until July six bears were fitted with temperature-sensitive radio-collars and four of these animals had temperature sensitive radio-transmitters surgically implanted. The transmitters have functioned throughout the summer and temperature data was collected on the average of twice each week. Flights will be made once or twice a month throughout the winter to monitor temperatures of denning bears.

John Hechtel, a graduate student and field technician from the University of Montana, was hired by the Animal Research Facility to follow a radio-collared grizzly and obtain information on behavior, habitat utilization and food eaten. Hechte also collected plant foods and feces samples for laboratory analysis. Much of the data collected by Hechtel will be incorporated into a Master's thesis.

Blood samples were collected from 26 bears for hematology and serum chemistry information. Urine samples were obtained from 6 bears. Blood and urine analysis is being done by the Animal Research Facility technician, Sally Manning.

Some of the results of Follmann's work were presented in a paper entitled "Thermal Significance of Curling Postures During Sleep in Wolves and Foxes" at the 28th Alaska Science Conference. Follmann has also prepared 2 additional papers this year on work done earlier (Table 2)

Follmann plans to continue his research at the facility during the next year. He has received tentative funding from ERDA to obtain five red foxes which would be used in a comparative metabolism study of Arctic and Red foxes. The objectives of this study would be to determine seasonal lower and upper critical temperatures, seasonal food consumptions and energetic efficiencies of these two species. Other proposed research for next year includes the feasibility of using heart rate (monitored by surgically implanted



radio-transmitters) as a measure of metabolism in penned foxes and a study on relationships between ambient air temperatures, internal body temperatures and activity patterns in Wolverines. Another study is planned with Mike Philo to determine upper critical temperature of foxes, wolves and wolverines.

#### VETERINARIAN RESEARCH

As the year-round full-time resident veterinarian at the Animal Research Facility, Dr. Mike Philo provides expert health care for animals maintained at the Facility and also conducts research. During FY77, his major research project was a continuation of a blood study initiated in 1975. Blood samples were collected in October, January, April and July from foxes, wolverines, and wolves. Hematological values, serum chemistries enzymes and electrolytes were determined by staff technician Manning. Clotting times and bleeding times were also measured. This study is obtaining base line information on blood parameters of northern species as well as seasonal and individual variations which may be related to cold adaptation.

Other research being conducted by Philo include a study to determine the effectiveness of using the drug xylazine (Rompum R, Chemagro) as a tranquilizing agent, and a study examining vaginal smears taken throughout the estrus cycles of canids. An extensive study of water balance in wolves is planned for the near future.

#### OTHER STAFF RESEARCH

A study to determine seasonal differences in activity patterns and social hierarchies in a captive wolf pack was completed by the Animal Research Facility staff member and volunteers during FY77. A pack of 6 animals was observed for 96 continuous hours in October, January and March. Some of the data obtained from this study was prepared in a paper presented by Pat Reynolds, Animal



Research Facility Supervisor, at the NW section meeting of the Wildlife Society (Table 2). Additional information will be prepared for publication within the next few months.

A study to determine seasonal changes in pelage thickness, body weights and measurements in foxes, wolves and wolverines is being conducted in conjunction with the seasonal blood census of these species. This information will be correlated with food consumption which is recorded daily for all species.

Growth curves of juvenile arctic foxes and wolves were determined from twice weekly measurements of body size and weight of the 5 wolf pups and 9 fox pups born at the facility this summer.

#### VISITING SCIENTISTS

During FY77 eight visiting scientists did studies at the Animal Research Facility. Dr. Tom Albert arrived in July from the University of Maryland to work at the Facility for a sabbatical year. His project on hibernation is entitled "Regional Heterothermy in Arctic Mammals". Thirty-four marmots and more than 50 Arctic Ground squirrels have been obtained for Albert's research. In addition he has imported 17 woodchucks from Maryland. His studies will include monitoring internal body temperatures of hibernating animals (via implanted temperature-sensitive radio-transmitters) and monitoring oxygen consumption and regional heterothermy in the following groups of experimental animals: 1. non-hibernating animals kept at room temperature, 2. hibernating animals, 3. non-hibernating animals which have been given serum from hibernating animals and 4. non-hibernating animals given serum from non-hibernating animals. This research will continue until July 1978.

Dr. John Baust from the University of Houston, visited the Animal Research Facility in June to discuss his research proposals. His study

entitled "Cellular Basis of Heterothermic Function in the Nervous System of Arctic Vertebrates" may be done at the facility next year. In order to begin his research he requested the aquisition of at least 24 live Arctic ground squirrels. The animals have been collected and are being shipped to him at the University of Houston.

Dr. Arnoldous Blix was here in April to do research on thermoregulation in young mammals. His project entitled "Physiological and Biochemical Adaptations in Marine Mammals" studied the physiological mechanisms of cold tolerance in a juvenile polar bear. A similar study on wolf pups was planned, but not carried out because of insufficient numbers of available animals.

Dr. Tim Casey returned to the Facility in August to complete a project entitled "Biophysics of Heat Exchange in Arctic Mammals." This research examined the thermal regime of lemming nests. He correlated results with earlier work completed on the bioenergetics of lemmings.

Dr. Edgar Folk of the University of Iowa requested support from the Animal Research Facility for two studies. Several brown lemmings were live-trapped for Folk's pineal gland study, which is still awaiting funding. Collection and analysis of polar bear serum after the bear was fed a diet of fat is being completed. This is part of Folk's study of kidney function which was to be completed during the summer of 1976.

Mr. Jack Lentfer of the Fish and Wildlife Service, along with Dr. Kjeksus from the University of Oslo and Dr. Blix from University of Alaska conducted a study in October to test the feasibility of implanting a radio-transmitter beneath the dorsal skin of a polar bear. A dummy transmitter was surgically implanted into the captive polar bear maintained at the facility. It was removed two weeks later when the incision appeared to be infected.

Dr. Larry Underwood from the Arctic Environmental Information and Data

Center, University of Alaska, was here in April and July to do research on his project entitled "Factors Affecting Cold Tolerance in Arctic Homeotherms". Underwood is determining low critical temperatures of Arctic foxes at different seasons of the year. He will be returning to the facility in October and January to continue this research.

Mr. Dave Bell of the Nansen Drift Station project donated the use of a fiber-glass hut for the Animal Research Facility isolation area. In exchange for the use of this building, facilities technician Selena Brotherton recorded maximum and minimum temperatures at various locations within the building during the month of May. This data, which shows the energy efficiency of the hut, was collected daily and sent to Dave.

#### SUPPORT FOR FIELD STUDIES

In addition to providing support for resident and visiting scientists the Animal Research Facility is used by biologists working in the field. Three wild polar bears were housed at the Animal Research Facility during February, May and June for Mr. Jack Lentfer of the Fish and Wildlife Service. The bears were eventually outfitted with satellite radio-collars and released on the pack ice.

Two scientists working on studies as part of the RATE program requested support from the Animal Research Facility this year. Dr. George Batzli from the University of Illinois requested food and supplies for his lemming project at Meade River. At the end of the field season, 24 lemmings and voles trapped at the field site were housed at the facility for several days until arrangements could be made to ship them to the University of Illinois. Housing was also provided for two fistulated reindeer utilized by Dr. Robert White of the University of Alaska in grazing experiments. The animals



stayed at the facility until planes were available to transport them to and from the field site.

#### PROJECT SUMMARY

Many of the research projects supported by the Animal Research Facility have not been completed and are continuing next year. But a partial list of publications and papers produced by scientists working at the facility in FY77 is shown in Table 2. Investigators who have not reported papers in preparation were not included in this bibliography. Some research done prior to 1977 at locations other than the facility was included because these papers were completed during the scientist's residency at the Animal Research Facility.

#### ANIMAL CARE AND MAINTENANCE

##### Acquisitions and Losses

Species and numbers of animals maintained at the Animal Research Facility change according to the needs of scientists using the facility. Table 3 shows the current population status of species at the facility.

There were no changes in the numbers of polar bears, wolverines or snowy owls at the facility during FY77. One adult female wolf was obtained from the Alaska Department of Fish and Game, but she escaped. Another adult female wolf died from unknown causes during the winter. A litter of 5 wolf pups were born on May 22. The pups were needed to replace losses over the past 3 years.

Two adult foxes were live-trapped in the Barrow area in Dec. and Jan. One died within a few weeks. Another adult female was sacrificed during a study of the animal's heart malfunctions. Three adults escaped from



the fox pen during the year. One of these animals was later found dead. A litter of nine fox pups was born at the facility on June 10. This is the first time Arctic fox pups have survived at the facility. The additional foxes are needed for potential research projects being conducted by Follmann, Underwood and Baust.

One adult ermine and all 3 least weasels were returned to the University of Alaska when Casey left the facility in November.

Thirty marmots have thus far been obtained for Albert's hibernation studies during the year. Seven juveniles were born at the facility, two juveniles were captured at Peters Lake. 7 were obtained from Driftwood, 10 were purchased from Natives in Anaktuvik Pass, and 4 were purchased from the Alaska Range.

Sixty six squirrels were also acquired from various locations in the Brooks Range. 40 were obtained from Driftwood. These included pregnant females who gave birth to 13 young. 8 were trapped at Peters Lake, 4 came from Meade River and one was captured at Point Lay. The squirrels will be used by Albert and Baust.

The brown lemming colony at the facility was terminated last fall when persistent disease problems plagued the animals. Ten juveniles and one adult were obtained in June from Barrow as a breeding colony for future needs. No collared, European lemmings or tundra voles were captured this year although old-age animals died. Five singing voles were live-trapped at Peters Lake. All but one escaped within a few weeks of capture.

#### IMPROVEMENTS IN ANIMAL CARE

During FY77 a program of upgrading animal care has continued. Animal diets were reviewed and changed on recommendation of the resident veterinarian.

Table 3. ANIMALS MAINTAINED AT THE NARL ANIMAL RESEARCH FACILITY DURING FY77

<u>SPECIES</u>	<u>1976 NUMBER</u>	<u>ACQUISITIONS</u>	<u>LOSSES</u>	<u>TOTAL</u>
Polar Bear	1	0	0	1
Wolf	19	6	2	23
Arctic Fox	9	11	5	15
Wolverine	3	0	0	3
Ermine	4	1	1	4
Least Weasel	3	0	3	0
Marmot	4	30	0	34
Arctic Ground Squirrel	5	66	6	65
Brown Lemming	0	11	4	7
Collared Lemmings	5	0	1	4
European Lemmings	3	0	2	1
Tundra Vole	4	0	1	3
Singing Vole	0	5	4	1
Snowy Owl	1	0	0	1

Dog chow was eliminated from the wolf diet in November which resulted in less digestive disturbances in the animals.

Major improvements in housing facilities included the construction of large weasel and lemming display cages. New wolf boxes were also built. The chicken wire lining the fox run has been replaced with heavy chain link fencing to prevent animals from escaping. Plywood flooring has been installed in all fox and wolf cages. An outdoor water tank was set up so that wolf cages can be hosed down during the summer months. A steam cleaner used for cage washing and sterilizing has been purchased.

New techniques for handling animals have been developed. Caretakers Craig George and John Smithhisler designed and constructed wolverine nest boxes with sliding doors and internal squeeze cages which greatly reduce stress on these animals during handling. Fox squeeze cages were also constructed.

The caretakers also built special housing for wood chucks and ground squirrels to be kept at room temperature for Albert's research. Thirty stainless steel rabbit cages were purchased and four large insulated hibernacula with removable nest boxes were also built for this project.

Timbers have been installed under all gates into the facility to eliminate dogs from coming into the compound and to prevent loose animals from escaping.

The caretakers prepared a written description of all animal care and handling procedures used at the facility.

#### PHYSICAL FACILITIES

##### Construction

During FY77 the new wing on building 350 was essentially completed. This wing contains the clinic and treatment room, recovery room, x-ray room, clinical lab, storeroom and two rooms for offices and laboratories. The water system



for the wing was installed in July. The rooms are being used now, but some additional wiring and the walls of the x-ray room and storeroom need to be finished. New cabinets, counter spaces and sinks have been constructed for the clinical lab.

Other major construction projects completed in FY77 included: 1) installation of a new water system in the food preparation room; 2) realignment of the Atco trailer adjacent to bld. 350 for use as office or laboratory space; 3) purchase and installation of a new compressor unit on one of the large outside storage freezers; 4) modifications on the environmental "cold room" to be used in Albert's experiments; and 5) construction of a venting system in the surgery room. An observation hut was moved adjacent to the fox pen to facilitate Follmann's research. Buildings within this compound were painted by ITT this summer.

#### EQUIPMENT ACQUISITIONS

During FY77 the facility has obtained a telemetric system designed for measuring physiological parameters on unrestrained animals. Twenty channel receivers and data processors capable of digital readout have been acquired. Internal temperature sensitive radio transmitters were purchased for foxes and bears. External temperature sensitive radio transmitters were obtained for foxes. These devices, mounted on collars worn around the animals' necks, also give information on the location of an animal and its relative activity. Equipment capable of additional physiological measurements such as EKG may be purchased in the near future.

New flow meters and a larger pump have been ordered for the metabolic chamber and analyzers. Air-tight boxes for wolverines and foxes have been built for use in the chamber.

The autoclave, purchased last year, was installed, modified with a



filling tank and was made usable by mid-September.

An osmometer has been purchased for the clinical laboratory.

#### STAFF AND VISITORS

Staff changes have occurred in every position at the facility during FY77. These changes are summarized in Table 4. The Staff currently consists of a facilities Supervisor, one research aid, one laboratory technician, 2 animal caretakers and one research associate. A second research associate position will be filled soon. Both of these research positions and the laboratory technician are funded by the Office of Naval Research Biophysics Program. There is also a resident veterinarian on the staff who is a member of the U.S. Army.

Tours of the facility were given to more than 250 official visitors in FY77. These included scientists, state and federal officials, military visitors and local residents. A self-guided tour outside the facility compound was initiated for visitors interested in "seeing the animals". More than 100 people have taken this self-guided tour.

#### SUMMARY

The NARL Animal Research Facility is currently sustaining an active in-house research program, supporting several visiting scientists and operating as a logistics base for field studies. As its reputation continues to expand, an increasing variety of arctic biological research will be supported. Because of its location, this facility offers unique opportunities for biological studies on arctic acclimatized animals. It is the only facility in North America where northern species of mammals are maintained in an arctic environment with its unique temperature and light regimes. These

Table 4. STAFF CHANGES AT THE ANIMAL RESEARCH FACILITY DURING FY77

<u>POSITION</u>	<u>INDIVIDUAL</u>	<u>DATE OF ARRIVAL</u>	<u>DATE OF DEPARTURE</u>
Facility Supervisor	Derek Craighead	-	Nov. 17
	Pat Reynolds	Nov. 1	-
Research Associate	Tim Casey	-	Nov. 24
	Erich Follmann	Dec. 13	-
Lab Technician	Kathy Casey	-	Nov. 24
	Carolyn Tremaine	Nov. 15	March 17
	Sally Manning	April 11	-
Research Aid	Katie Persons	-	Nov. 1
	Selena Brotherton	Nov. 15	May 26*
	Atsuko Ohtake	May 30	Aug. 12
Caretaker	Gary Seiler	-	May 6
	Craig George	May 12	-
Caretaker	Jay Crenshaw	-	June 3
	John Smithhisler	June 8	Aug. 12
	Tim White	Aug. 8	-
Student Field Assistant	John Hechtel	May 15	Sept. 18

\* Employee will resume position on Oct. 1, 1977

conditions cannot be duplicated in artificial light-dark rooms or temperature chambers. As research is done on these specialized mammals whose physiological and behaviorial processes of adaptation are highly magnified under arctic conditions, we will come to better understand how these same processes function in man.



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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER Technical Report No. 1	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) BIOPHYSICS OF COLD ADAPTATION AND ACCLIMATIZATION NARL ANIMAL RESEARCH FACILITY ANNUAL REPORT FOR FY 77.		5. TYPE OF REPORT & PERIOD COVERED Annual, FY 77 (Oct. 1, 76 to Sept. 30, 77) to a continued contract
7. AUTHOR(s) Dr. Gary A. Laursen		6. PERFORMING ORG. REPORT NUMBER
9. PERFORMING ORGANIZATION NAME AND ADDRESS Naval Arctic Research Laboratory, Science Dept. Animal Research Facility Barrow, Alaska 99723		8. CONTRACT OR GRANT NUMBER(s) N00014-77-C-0162
11. CONTROLLING OFFICE NAME AND ADDRESS ONR Code 444, Biophysics Program Office 800 N. Quincy Street Arlington, Va. 22217		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS Task #NR 207-117
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		12. REPORT DATE 15 October 1977
		13. NUMBER OF PAGES 23
		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
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18. SUPPLEMENTARY NOTES Submitted in compliance with Biophysics Program Report Requirements		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Cold Adaptation, Cold Acclimatization, Arctic, Homeotherms Biophysics, Mammals		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The Animal Research Facility (ARF) at the Naval Arctic Research Laboratory (NARL), Barrow, Alaska, provides scientists with logistic support and unique opportunities to study Arctic mammals maintained in an Arctic environment. During FY 77 seventeen (17) in-house, visiting and field research projects resulted in 3500 man-hours of support of work conducted by fifteen (15) scientists. Research was conducted in the areas of: comparative thermoregulation; cold adaptation; cold acclimatization; >over		

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social hierarchy; growth responses to seasonal changes in climatic conditions; water balance; regional heterothermy; heat exchange; radio telemetry (rates and temperatures); threshold tolerances to cold; and ecological studies.

Thirteen Arctic mammal species, all native to Alaska's high Arctic North Slope, were used in the experiment. Major improvements were completed at the facility and new techniques for handling the animals were developed through squeeze caging.

A